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Pages 18-28

The AMU-DARYA at the Present Time

The Amu-Darya is the largest river of Central Asia. It is 2336 kilometers long. The sources of the Amu-Darya are in the mountainous regions of the PAMIRS and the HINDUKUSH at an altitude of 5000 meters, where there are snow and glaciers all year round. The upper part of the Amu-Darya flows through mountains while its middle and lower courses flow through the desert plains of Central Asia.

At its extreme upper part the river is called the PYANDZH, and it is called the Amu-Darya only after flows into it the river VAKHSH. Many tributary streams flow into it while it is coursing through the mountains. The largest of these tributary streams are the rivers: KAFTIRNIGAN, SURKHAB and SHIRABAD. While it is flowing through the desert plains the Amu-Darya does not have any tributaries. It flows out of the mountains between Mount CHARDARA and Mount KERKI. For 1,036 kilometers the river is wide and has a swift current as it flows across the desolate sandy deserts KARA-KUM and KZIL-KUM and finally flows into the Aral Sea. The delta of the Amu-Darya starts about 150 kilometers from the Aral sea near the city MUCUS. The river breaks up into an intricate system of streams that form many lakes and flooded areas which are covered with reeds and rushes. This system extends down to the sea. Over its entire middle and lower courses the water of the river irrigates several agricultural (farming) oases of the TURK S.S.R. Along its middle course are the cities KERKI and CHARDZHOY. Along the lower course are the extensive oasis areas within the KARA-KALPAK A.S.S.R., within the TURK S.S.R. and within the KHOREZM province (oblast) of the UZBEK S.S.R. (the cities of [illegible], TASHAUZ, URGENCH, and others).

In the Central Asian plains the Amu-Darya flows in a wide, level valley covered with deposits carried by the river. A large part of this valley is either the present or ancient bed of the river. Most of the part of the valley that is close to the river is a flood-plain (water-meadow) and it is covered with densely growing weeds and thickets of arboreous-scrub, flood-plain vegetation. In parts of the valley more distant from the river, and here and there close to the river there are areas of dried up flood-plain. Because these latter areas are not inundated by flash floods and because the subterranean water level has sunken, desert type vegetation flourishes on them and relatively quickly crowds out the flood-plain type of vegetation. The areas

that used to be the river bed and also in the dried up flood-plain areas (these latter are often caused by the construction of special dikes to protect them from water during flash floods) there are sections of land that are artificially irrigated.

The Amu-Darya gets its water from melting snows and glaciers in the mountains of its enormous watershed. The river has two flood periods, the spring season (April-May) and its main one, the summer season (June-July). The earlier flood is caused by the melting of the snow in the foothills and the summer flood is caused by the rapid melting of the high altitude mountain snow and glaciers during the hot part of the year. The regimen of the river is very favorable for the development of irrigation, since the period of the year when the river has the most water corresponds to the period when cotton plants and perennial grasses require the most water for growth. The overall flow of water in the Amu-Darya exceeds that of the DNIEPER. This is brought about by the Amu-Darya's large watershed area and by the high specific water-bearing characteristics of its watershed, in conjunction with the fact that this area is located along the route of moisture-laden air masses that are blown along by west and southwest winds (and which, thanks to their altitude (3.4 kilometers, average) retain a large part of their moisture). The annual average volume of water that the river carries as it flows out of the mountains (near the city, KERKI) is approximately 2, [illegible] cubic meters (M^3) per second. At the beginning of the delta (near the city, [illegible]) the volume of water is approximately 1,500 cubic meters per second. The average yearly current is about 60 cubic kilometers of water per year, with fluctuations between 50 and 70 cubic kilometers per year. Since the river is fed by inexhaustible reserves of high mountain snow and glaciers the river is distinguished for lack of fluctuation in its current from year to year. The normal variations from year to year are less than 10%.

From these figures it is evident that over its middle course - from the spot where it comes out of the mountains down to its lower course (between the cities of KERKI and [illegible]) the Amu-Darya loses 25% of its water to irrigation, evaporation and filtration. Of this 25% about 1[illegible]% is used for irrigation. A large part of the waters of the river are thus expended for irrigation or are lost by evaporation on the lower reaches of the river and in its delta. Despite this, however, a large portion of the river's water reaches the Aral Sea. This mighty river is the main feeding artery of the Aral Sea and as a result the water level of the Aral Sea depends closely on the volume of water in the Amu-Darya.

General schematic calculations show that at the very least the water of the Amu-Darya could irrigate 4½ million hectares of irrigable land. At the present time the sum total of land being irrigated by Amu-Darya water is only 800,000 hectares. Thus, the opportunity exists for taking hydro-technical measures which would increase the amount of irrigated land in the river basin by several times and would create enormous areas of new, irrigated oases. These areas could be used to grow the extremely valuable heat-loving, southern agricultural crops (chiefly cotton).

The overall fall of the streambed of the Amu-Darya over its course through the plains, and even throughout its middle or lower courses is very great. It falls ten times more than the VOLGA. This significant incline in combination with the huge volume of water causes the river to have an extremely swift current. Almost throughout the entire length of the river the water rushes along forming many whirlpools. Within the limits of its valley the river meanders greatly and usually consists of an intricate system of secondary channels with numerous shallows and sandy islands. Even over its middle course, the river's secondary channels are very impermanent. They often change location and quickly wash out the bank. The Amu-Darya practically does not have a permanent channel and its banks are always being destroyed by washouts and crumbling. The hydrology of this muddy river is extremely capricious and changeable.

These spontaneous, natural factors played a very important part in the history of irrigated agriculture along the Amu-Darya. The primitive methods and means of water control that had existed for many centuries protected the farmer's fields poorly. Often when the river was in flood it would destroy the head gate of irrigation canals and flow off into the main channel leaving tilled land without water or on the contrary it would burst the side retaining walls and flood wide areas of tilled land.

Within its delta area the Amu-Darya has changed its primary direction many times. This brought about the relocation of irrigated farming areas from one section of the delta to another.

Until the 12th century (according to V. V. BARTOLDU) the Amu-Darya irrigated the intensively east part of its delta ~~xxxxxx~~; from the 13th to 16th century it did the same for its western delta area, and from the 16th to the beginning of the 19th century it once more irrigated its eastern delta area.

The "switch" in the Amu-Darya during the 13th century (at which time it moved toward the [illegible] BASIN) was caused by the destruction of the irrigation system during the MONGOL invasion. When it was freed from its restraining influences the river changed

its course to the west. The subsequent "switch" of the river back to the east was hastened by the reconstruction of the irrigation systems of southern KHOREZM during the 15th and 16th centuries.

As a consequence of this the "[illegible]" bed of the Amu-Darya, the river KUNYA-DARYA, gradually died away and the largest oasis on the KUNYA-DARYA during the middle ages perished because of the lack of water. This oasis included the cities V[illegible]ZIR and ADAC.

At the end of the 18th century the main direction of flow of the Amu-Darya once again shifted to the west. This shift of physical geographical factors changed the delta of the river and permitted the KARAKALPAKS to carry out more extensive land drainage and irrigation. It was during this period that the KARAKALPAKS emigrated from the basin of the river SYR-DARYA into northern KHOREZM.

At the beginning of the 19th century the left bank channel, LAUZAN, became the largest one. Its waters ran into the AYBUGIRSKII depression and from there they overflowed and spread along the USTYURT escarpment (a precipitous cliff or steep terrace) to the sea. The flooding of the left bank bayous in the lower reaches of the Amu-Darya enabled the local inhabitants to increase the amount of land tilled in the vicinity of KUNYA-URGENCH and DARYALIK. The KHAN of KIVIN used might to force the KARAKALPAK peasants into this region and they developed a series of large canals (KARAKALPAK-TARGAN, [illegible]-YAB, and others). The newly irrigated region was called KHAN-ABAD.

The switch to the west of the main flow of the Amu-Darya brought about a shortage of water in the eastern basin of the KOK-UZYAK. The KARAKALPAKS who had settled in this area had to build new canals and rebuild old ones. In the forties of last century the KARAKALPAK [illegible]AN dug an irrigation canal from the middle reaches of the KOK-UZYAK to the old beds of the river. The high water flowed off in the new direction and out of the old bed of the river KOK-UZYAK. The new channel, thus created, flowed into the DAUKARINSKII flood plains and was named the KUVANISH-DZHARM (see Map titled "The Cultivated Zone in the Lower Reaches of the Amu-Darya in the Year 1940).

The continual changes in the volume of water in the delta bayous brought about instability in the irrigation system of northern KHOREZM and resulted in endless bickering and quarrels among tribes and clans of the KARAKALPAKS and the northern UZBEK. During the period when the area was administered by czarist colonial bureaucrats (just as during the period of the KUNGRADSKII KHANATE) no proper and just

decision was able to be reached as to how to divide the water among the farmers. It was only the Great October socialist revolution which freed the workers from the exploiters, gave the land and water to the people and guaranteed that the water would be distributed in irrigated areas in a just and proper manner.

The greatest change in the delta of the Amu-Darya occurred in the fifties of the 19th century. On the one hand it led to the catastrophic flooding of the wealthiest agricultural region populated by KARAKALPAKS along the KUSHKAN-TAU hills, and on the other hand it brought about the complete deprivation of the KUNYA-URGENCH area to the west of water.

This natural calamity was caused by the closing of the left bank irrigation canals by the KHIVINSKII government as an act of repression against the revolting TURKMEN population. A contributing cause of the change in the main direction of the Amu-Darya was also the stoppage of the seasonal irrigation reconstruction operations in the delta during the economic and political crises that occurred in the fifties. Barrier dams were destroyed and washed out by flood waters which finally inundated an enormous cultivated area between KARABAIL and CHORTANBAI.

Map on Page 23

1. The Cultivated Zone in the Lower Reaches of the Amu-Darya in the Year 1840

2. [illegible]	17. KARABAILI	32. Amu-Darya
3. [illegible]	18. SHOMANA	33. Porsu
4. [illegible]	19. ISHAN	34. KIPCH K
5. [illegible]	20. CHORTANBAI	35. MANGIT
6. [illegible]	21. KIRDZHELI	36. YANI-SU
7. [illegible]	22. [illegible]	37. ICHEM
8. [illegible]	23. KUNYA-URGENCH	38. DAUKARA
9. [illegible]	24. KUNI-YAB	39. kilometers
10. [illegible]	25. DUMAN-BEYI	End of Map
11. [illegible]	26. LAU [illegible]	
12. [illegible]	27. SIINAI-YAB	
13. [illegible]	28. K[illegible]ELI	
14. [illegible]	29. CHI[illegible]I	
15. [illegible]	30. KUV[illegible]	
16. [illegible]	31. TAKHIA-TASH	

From that time on there have been extensive areas covered by flood waters in the central part of the delta of the Amu-Darya. Practically the entire western part of the delta (KUNYA-DARYA, SHOMANAI, KIYAT-DEHKHAN, TALDIK) is gradually drying up (see Map titled "Cultivated Zone in the Lower Reaches of the Amu-Darya in the Years 1880-1890"). In an attempt to hold on to the vanishing water the people of northern KHOREZM built an entire system of dams on the TALDIK and ULKUN-DARYA during the sixties. This was fruitless however. The KUNYA and SHOMANAI agricultural regions were doomed to ruin. The loss of cultivatable land in the western part of the delta could have been prevented only by an extensive system of irrigation measures which it was impossible to construct under the KHANATE or under the colonial czarist regime. The final, comprehensive solution to the problem of irrigating the western part of the delta (KUNYA-URGENCH, KHODZHEYLINSKII and KUNGRADSKII regions) was achieved by the construction of a great work of communism - the Main TURKMEN Canal - from the Amu-Darya to KRASNOVODSK.

During the end of the 19th and the beginning of the 20th centuries the western part of the delta continued to dry up (see Map titled "The Cultivated Zone in the Lower Reaches of the Amu-Darya in the Years 1910-1920". During the nineties KIYAT-DEHKHAN was evacuated, and in 1910 SHOMANAI was also left empty. It was only under the Soviet regime, after the reconstruction of the system named for Lenin, that these most fertile areas of the delta were brought back to productivity. During the Great Fatherland War (WW II) the KARAKALPAK A.S.S.R. completed the construction of the new SHOMANAI CANAL and the lands which had been taken over by the desert once more were green with crops. These crops were, however, no longer sorgum and grains but were instead the main commercial crop of the lower reaches of the Amu-Darya, cotton.

The decree of the Council of Ministers of the U.S.S.R. concerning the construction of the Main TURKMEN Canal from the Amu-Darya to KRASNOVODSK opened up a new era in the development of the production ability of KHOREZM and TURKMENIA. The Main Turkmen Canal can irrigate about 800,000 hectares of dried up land in the KARAKALPAK A.S.S.R. and in the northern regions of the Turkmen S.S.R. within the delta of the Amu-Darya (see Map titled "The Cultivated Zone in the Lower Reaches of the Amu-Darya in the years 1940-1950). The building of the magnificent dam near TAKI-TASH is a feat of the new communist society and it subjugates the mighty river to the will of the society. The danger of the levees failing and consequent flooding in the delta of the river is now

forever past. The Amu-Darya is now chained into specific channels and provides its life - giving waters for the fields of the collective farms.

1. Map titled "The Cultivated Zone in the Lower Reaches of the Amu-Darya in the Years 1910-1920".

2. AR[illegible]	12. ISHIM
3. TALDIK	13. CHIMBAI
4. KUBL-TAU	14. KESKYLI
5. KUNRAD	15. TAKHIA-TASH
6. SHABAKLI	16. YANI-SU
7. kilometers	17. KUVANDOK-DZHARMA
8. KU SHKANA-TAL	18. AMU-DARYA
9. KHANI	19. KIPCHAK
10. KU[illegible]YLI	20. KA[illegible]TI
11. KUNA-UR[illegible]OW	End of Map

The water of the Amu-Darya is a yellowish-brown color and is always muddy. Because of the high speed of the current (more than two meters per second) and the high volume of water the river carries an enormous amount of suspended alluvium (twice as much as the river NILE, for instance). During the flood stage the muddiness of the water reaches a point where the alluvial particles in one cubic meter of water weigh 6 - 12 kilograms. The average muddiness of the water is 2½ - 3.2 kilograms of silt per cubic meter of water. This means that in only a single year the Amu-Darya deposits 150-200 million tons of silt. Most of this silt is particles of dust and clay (85% of the particles are less than .05 millimeters in size and between 50 and 55% of the particles are less than .01 millimeters). These particles have a high content of calcium carbonate, sodium chloride, potassium and phosphorus, which of course are the most important mineral elements in the nutrition of plants. This is the reason that the low marshes of the Amu-Darya are so highly fertile. Due to their natural characteristics the silt in this area is more fertile than the famous silt in the delta of the Nile. However, this silt does have several negative physical characteristics that are the result of the large amount of clay in it.

The construction of the TAKHIA-TASH dam in the lower reaches of the Amu-Darya will have a restraining effect on the amount of water the river will contain down at its

delta. In this area the river will to a large extent be tamed. The construction of the new irrigation canals and the reconstruction of the existing irrigation net (using modern techniques and equipment) will afford complete mastery over the waters of the Amu-Darya, so that they can be used to irrigate the land along the river's lower reaches.

Thus, in addition to an enormous increase in the amount of irrigated land, the construction of the Main Turkmen Canal and the new irrigation system connected with it, will guarantee effective utilization of the hydrologic peculiarities of the Amu-Darya and will also provide mastery of the spontaneous, destructive floods and washing away of the river banks along the river's lower course.

1. Map titled "The Cultivated Zone in the Lower Reaches of the Amu-Darya in the Years 1830-1890".

2. [illegible]
3. [illegible]
4. DARYALYK
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. SHAHANAI
10. kilometers
11. ULKEN-DARYA
12. KUSHKANA-TAU
13. ISHAN
14. KHOJAH-YLI
15. KHIVA-URGUCH
16. KHAZYLI
17. KAUPIR
18. KUVANISH-DZHARYA
19. AMU-DARYA
20. PORAU
21. KIPCHAK
22. KANGIT
23. YANI-SU
24. ISHIN
25. DAUKARA

End of Map

Pages 144-166

Part Three

THE TYPICAL PLAN FOR DIVERTING THE WATERS OF THE AMU-DARYA WITHIN THE TURKMEN PART OF THE TURKMEN S.S.R. AND THE PERSPECTIVES FOR DEVELOPMENT OF IRRIGATION ALONG THE LOWER REACHES OF THE AMU-DARYA.

Historic Facts about the Flow of the Waters of the Amu-Darya into the CASPIAN SEA

It is doubtful that there are many rivers with so confused and completely

puzzling a history as the Amu-Darya. There is a long list of historical documents which refer to the Amu-Darya and refer to it as one of the greatest rivers of Central Asia.

Beginning with [illegible] (450 B.C.) and [illegible] (140 B.C.) many ancient writers have referred to the AKSU (or [illegible]) -- the ancient name of the Amu-Darya.

It is extremely interesting that in the works of almost all authors mention can be found that relatively not long ago (historically speaking) the Amu-Darya flowed into the CASPIAN [illegible]. Such writers as HERODOTUS, POLIBIUS, STRABON, PLINY, PLUTARCH, PTOLOMEY (Second Century B.C.) wrote about the above.

They even provided such details as, "One could hear the noise of the waterfalls from a considerable distance away" (from the Persian geographer KHA[illegible]). Polibius, too, refers to, "three waterfalls," which formed clear paths behind their streams of water, and it was along these paths that the nomads advanced to make their raids.

ABDUL-GAZI-BAHADUR, one of the KHANS of KHOREZM, wrote in his "History of the Mongols and Tartars", "At that time (i.e. about the year 1525 - ed.) the entire road [illegible] from URGENCH to ABDUL-KHAN (the mountains - Large and Small BALKHAN - ed.) was covered with villages because the Amu-Darya flowed below the very walls of URGENCH and then later turned westward and near [illegible] URGENCH emptied into the KHVALYNSKOYE Sea."

In the "Book of the Great Map" which contains the map of the MONGOL state there is a line which reads, "170 VERSTS from the city of NAKHARA the river flowed out of [illegible] Lake KUS, or as we call it Lake BY". From there it flowed 1000 VERSTS to the KHVALINSKOYE Sea." For the word KUS one should read OKUS, the ancient name for the present-day Amu-Darya. Also, the distances indicated in this book are very close to the correct ones.

Many Eastern historians and geographers also state that long ago the river DZHEYKHUN (Amu-Darya) emptied into the Caspian.

Early day west-european maps, as is well known, did not show the Aral Sea and depicted the Amu-Darya as flowing into the Caspian Sea. The Russian explorer, K. M. BAER wrote, "It may seem incredible but it is nevertheless true that the educated world knew nothing about the existence of the Aral Sea until the era of Peter." When Baer wrote "educated world" he had in mind west-european cartographers of his time. Surveying of the borders of the Aral Sea, depicting the Aral Sea, on the geographic maps, with the Amu-Darya emptying into it, and the discovery of UZBOY were all done by

Russian cartographers during the era of Peter and were the results of investigations in this field that were started by Peter the First.

The direct cause of the expeditions sent out to map the Aral Sea borders was a story by a PERSIAN, KHODJI (KHADJI) [illegible] who traveled to ASTRAKHAN in 1713. The story was about golden sand "Sandy Gold" and told how the KHIVINSKI KHANS filled in the channel through which the Amu-Darya flowed to the Caspian in order to ensure their continued reign. According to this TURKMEN, it would be easy to destroy the dam thus created and cause the river to flow once again through its old channel to the Caspian.

On 20 May 1714 Peter the First issued an order announcing the organization of the first expedition, "To go to KHIVA with greetings to the KHANATE, thence to BUKHARA to the KHAN, to look for commercial opportunities or others that may exist, to visit the city [illegible] ([illegible] - ed.) and find out how far it is from the Caspian Sea and to determine if there is not a river that flows from that city or from its vicinity into the Caspian."

In order to carry out this order, later in May of the same year another one was issued which assigned Alexander BEKOVICH-CHERKASSKY to go on the expedition. When he arrived in ASTRAKHAN on 1 Sept. 1714 he wrote to APRAKSIN, "I have learned from the inhabitants of Astrakhan about the river Darya - where it comes from, where its mouth is. They say this is no small river. It starts in India, flows through the lands of [illegible] and KHIVA and empties into a lake called the Aral Sea. This lake is 14 days' travelling from the Caspian Sea. Other people here state that there is a small channel that flows from the lake to the Caspian. Although some people here state that this has been seen I haven't found a man who saw it." This was the first correct information about the true course of the Amu-Darya and it contradicted the opinions of the west-european scholars of those days who believed the river emptied into the Caspian.

BEKOVICH-CHERKASSKI'S first attempt to reach his objective in 1714 was unsuccessful. However, on 25 April 1715 he and his men left ASTRAKHAN and headed for the sea. They reached the bay TYUBE-KA AGAN. The local people were subjects of the AYUKI-KHAN and had early become Russian citizens. They stated that it was only necessary to dig a canal twenty versts long down to a bay of the Caspian - to the Red Waters, and the Amu-Darya would once more flow into the Caspian BEKOVICH-CHERKASSKI sent KHODJI-NEFES A and two Russian noblemen, FEDOROV and IVANSKI, to look over the area. These three carried out their task and reported that near the river KARACH they had discovered an earthern wall about five versts long and three sajens wide that, according to the local

inhabitants ran to within two versts of the Amu-Darya. The explorers then turned to the right and soon reached a valley which the same local people said ran all the way down to the Caspian and was the ancient bed of the Amu-Darya. There were elevations along both sides of the valley that looked as if they might have been river banks at one time and there were also the ruins of early settlements on these elevations. Here and there narrow, dry ravines ran off from the valley and they resembled early dry canals. When they reached the limit of the territory of ATA-IBRAHIM the men sent out by BEKOVICH-CHERKASSKI turned around and went back to BALKHANSKI BAY. It was through this expedition that the first more or less true information on the AMU-DARYA was gotten.

As can be seen from the letter BEKOVICH-CHERKASSKI wrote to Peter I on 4 August 1715 he himself actually visited the spot where in earlier times an arm of the Amu-Darya had flowed into the Caspian. The letter read, "I reached the spot called AKCHA, where the Amu-Darya used to flow into the Caspian Sea. There is no water here nor nearby at the present time. For several reasons the river was dammed up by a weir where the KHAN of KHIVA territory starts. This is four days' travel from KHIVA. This weir forces the river to flow down into a lake called the Aral Sea." Thus, in the year 1715 the BEKOVICH-CHERKASSKI expedition discovered the mouth of the AMU-DARYA (explored in detail in 1 25 and 1826 by BUTENEV and LEMANSKI). In 1716 Peter I placed BEKOVICH-CHERKASSKI at the head of a new expedition. The order given to him on 14 February 1716 clearly indicated the missions of this venture. They were:

1. "Go to the spot where the mouth of the Amu-Darya used to be and construct a fort that will hold 1,000 men."

2. "Go to the KHAN of KHIVA as our ambassador and find out how to get to the river and exactly where the dam is. If possible switch the river back to its old course and block up the entrance of the river into the Aral Sea."

The order also instructed him to send people out to look for gold near the YAIK and to ask the KHAN of KHIVA for ships in order to send them on a commercial voyage along the Amu-Darya to India. On this voyage the ships were to be sailed for as long as possible on the way to India, all lakes and rivers were to be taken note of, and the entire route, both land and water but particularly water, were to be described.

We see how Peter I tried stubbornly to find a water route from the Caspian to India. He even tried to switch the Amu-Darya and use this route or other rivers flowing to TURKESTAN if possible.

On 9 October 1716 BEKOVICH-CHERKASSKI arrived at Bay TYUBE-KARAGAN after leaving from ASTRAKHAN. From here he sailed his flotilla of ships to the "Bay of Red Waters" where he arrived on 3 November 1716 and started building the fort. In comparison with the earlier expedition this one did not contribute anything substantial to help clear up the question of the ancient bed of the Amu-Darya. Later on in 1717 BEKOVICH-CHERKASSKI left Astrakhan with some men and set out for GURYEV and thence overland to KHIVA, where he and most of his men were treacherously killed.

BEKOVICH-CHERKASSKI'S unsuccessful venture did not end the attempts to determine exactly where the river Amu-Darya flowed and where its ancient course lay. This task and similar ones were assigned to the chief of the Russian embassy in BUKHARA and Persia F. BENEVENI who left Moscow in September 1718.

BENEVENI spent more than six years travelling and in his reports he stated, "It is thought that in the olden days the Amu-Darya flowed into the Caspian Sea. It was not the entire river that flowed into the Caspian, but only half of it. No one can state absolutely why the water of the river was deflected or how strong the dam is that deflected it." He also expressed his opinion that the KHIVINTSY KHANS had done it during a war against BUKHARA and KHIVA; when finding themselves unable to defeat the latter they decided to deprive them completely of water and thus force their enemies to retreat and leave the area. It is important to note that although BENEVENI was confirming the existence of the ancient bed of the Amu-Darya he also emphasized the fact that it was only an arm of the river and not the entire Amu-Darya.

Beneveni sent his valet, [illegible]ER, back from BUKHARA to Russia and this latter also stated that the river UZBOY had existed in the past and he provided detailed information about the sources and upper reaches of the Amu-Darya.

As a result of the expeditions of BEKOVICH-CHERKASSKI and the mass of data that was collected after his death during the era of Peter I in an attempt to determine the actual course of the Amu-Darya and of its ancient bed, the UZBOY, an extremely valuable map of the Caspian and Aral Sea area was compiled. This map was unearthed by Academician L. S. B[illegible]G, who believes that the map was prepared in about 1723.

Sketches of these two enormous lakes are shown on this map with an accuracy of detail that was uncanny for those days. The Amu-Darya is shown as flowing into the Aral Sea by means of several arms. From the delta of the Amu-Darya there is a dry channel running to the BALKHANSKI Bay (from the dam at KARAKUCHI). Over the lower section of this channel is the inscription "former mouth of the Amu-Darya". In the lower left-

hem corner of the map there is another inscription which reads, "From the former mouth of the Amu-Darya to the dam at KARAKACHI (where the river is held back) is twelve days' travel, and from the dam at Karakachi to the Aral Sea is two days'. From the dam to the city of KHIVI KIVINSKIT ([illegible] - ed.) is one day's travel."

This map is characteristic of the high level of Russian sciences during the era of Peter and it solves an interesting geographic problem for us concerning portions of the Aral-Caspian Basin and the ancient bed of the UZBOY.

We see that Russians had enough accurate data about the UZBOY even before the era of Peter I, and that even then they were working on the problem of diverting the waters of the Amu-Darya into the Caspian, but that under the social conditions that prevailed and with the production capacity, equipment and techniques that existed in those days it was impossible to divert the waters of the Amu-Darya from the Aral Sea to the Caspian Sea.

In later days the problem of the Amu-Darya was given no attention by the Russian government until the eighties of last century.

Individual bits of information about the ancient bed of the Amu-Darya, now called the Western UZBOY, were collected only as a by-product result of military reconnaissances while Russian troops were moving eastward from the Caspian. However, the beginnings made during the time of Peter I were not forgotten in Russian scientific circles. In 1839 the Academy of Sciences suggested that a scientific expedition to KHIVA be organized, calling to the attention of the czarist government, 'that if the ideas of Peter I are found to be capable of implementation then the results would be incalculable."

Starting in the year 1873, after the Russians had gotten into KHIVA, the question of whether the Amu-Darya had formerly flowed into the Caspian was thoroughly discussed. The discussions were based on study of the Amu-Darya itself and its ancient bed.

The work of the expedition headed by General GLUKHOVSKI in the years 1879-1883 merits much attention. This expedition made the first diagrams using instruments of the large channels where the ancient Amu-Darya bayous flowed. In addition the expedition determined the dimensions of the SARYKAMISHSKI BASIN.

The precision level survey run at that time along the Western UZBOY river from ARNAUTI K to the Caspian Sea has not lost its utility, as the only instrument survey of the UZBOY, right up to the present day.

The mission of Glukhovski's work, as he explained it in a book published in 1893, was "To force the water of the Amu-Darya to flow through its old bed to the Caspian Sea and thus form an uninterrupted water route (Amu-Darya -- Caspian Sea) from the border of AFGHANISTAN along the Amu-Darya, the Caspian, the Volga and the MARINSKI SYSTEM to St. Petersburg and the Baltic Sea." Glukhovski's work drew the attention of scientific circles and in 1893 in Chicago, at the World's Fair he was awarded a gold medal.

Naturally, while Glukhovski was searching for the old water routes he was strongly under the influence of the historic information and traditions indicating that in the comparatively recent past the Amu-Darya had run to the Caspian. Basing his theory on this information, Glukhovski imagined that the current stopped flowing to the Caspian in about the XVI century and that it would not require extensive equipment to make it resume its old course.

Such a preconceived opinion naturally affected the early direction of Glukhovski's work. His first choice for the water route was the channel which would be formed if the lower reaches of the Amu-Darya were switched so that this portion of the river would run west. This plan made maximum utilization of the ancient path of the Amu-Darya to the Caspian (it ran along the bed of the KUNI-DARYA, across the SARYKAMISHSKI BASIN and thence along the bed of the UZBOY.

Ships moving along the water route through SARYKAMISH could only move unhindered on the section from the Amu-Darya to the UZBOY. The UZBOY itself is not suitable for navigation in its natural state. Its bed does not slope evenly to the Caspian but rather is a series of main river channels that start abruptly at different levels. In its normal state the UZBOY is a chain of long reaches of water between sandbars and the current is very weak. The stretches of water between the sandbars are here and there broken up by short stretches of wild current with rapids and occasional waterfalls.

In order to make the stream navigable Glukhovski intended to build ten dams with navigation locks along the UZBOY.

There would have been no obstacle to navigating across the SARYKAMISH BASIN after it was filled with water and turned into a lake, but the task of filling the basin with water turned out to be the major obstacle to the implementation of the project to make the Amu-Darya flow into the Caspian.

The bottom of the SARYKAMISHSKI Basin is below the level of the Caspian Sea, but the start of the UZBOY is above the Caspian Sea level. As a result, before any water would flow out of the Basin and along the UZBOY, the Basin would have to be filled to a

depth of 100 meters. This would amount to a volume of water that was approximately 320 cubic kilometers and a total watersurface of about 9600 square kilometers.*

* By means of later information it has been determined that to the surface area of the filled up SARYKAMISHSKI LAKE the area of SARA-KAMIN Bay must be added and this results in a water surface area of about 12,000 square kilometers.

According to Glukhovski's figures it would take 15-17 years to fill the Sarykamishski Basin and this of course significantly lowered the effectiveness of the entire undertaking.

Navigation of shallow draft ships across the Sarykamishski Lake would be dangerous if there were high winds and a by-pass canal, similar to the one at Lake LADOGA, would have to be built to facilitate crossing the lake. This factor greatly increased the cost of constructing the route.

Glukhovski decided that his first choice, the water route by way of Sarykamish, was not practical, and he settled on a second plan. This entailed an artificial canal to detour Sarykamish. For this route the upper section was also to be the bed of the MUI-DARYA, along whose bed the route would extend for about 170 kilometers.

After the route left the MUI-DARYA it was to flow into another ancient stream, the DAUDAN. The route proceeded along this stream until the 300th kilometer was reached. From this point to the well of CHIRLYA the route would proceed for 100 kilometers along an artificial canal under extremely difficult conditions, since the area is dotted with high sand hills and crescent-shaped sand dunes.

The chief difficulty to this consists of the fact that this section of the canal would have to be constructed with an extremely small longitudinal slope and the current would therefore be very slow. This would bring about the clogging of the canal by the large amount of sediment carried and would make it necessary to dredge the stream bed continually. If this dredging were not done the canal would no longer operate.

Glukhovski's project and his book attracted attention by the courage of his convictions and by the expressed certainty for carrying out this grandiose task.

Glukhovski's certainty was confirmed by his belief that in reality all he was doing was using artificial measures to restore the waters of the Amu-Darya to the Caspian Sea, a route they had used comparatively recently. His convictions were also supported by quotes from many ancient authors and by the testimony of eye-witnesses.

In actuality, the wealth and detail of these indications were enough not only to

convince Glukhovski, a man who by nature preferred direct action as contrasted to the historical and natural sciences, but also to convince the famous Russian historian-Eastern expert BARTOLD. He based his conclusions on the same historical testimony and stated that between the XIII and XVI conturies the Amu-Darya had flowed into the Caspian Sea.

Naturally, such a high degree of conviction inspired all of those people who were working on this fascinating problem. The best proof that all these projects were actually capable of being carried out is the bare fact that all the artificial measures suggested were only necessary in order to restore the Amu-Darya to its natural course (which had been disturbed by man) and have it take its old route to the Caspian Sea.

Many people maintained the same convictions. In fact, many people who actually believed contradictory information arrived at the same conclusions. These conclusions were that the river's western course had to be considered almost as natural and normal a course as the course that led into the Aral Sea. The following is some of the information on which this is based.

It is a known fact that the slowing down of the river's current in its delta resulted in depositing of the silt with which the waters of the Amu-Darya are generously endowed. This causes a gradual raising of the river bottom and of the water level (the river itself actually raises its bed). At the present time during the flood seasons of the year the water level in the lower reaches of the Amu-Darya is higher than the river's natural banks.

All along the river, within the limits of the KHOREZM oasis, there are man-made levees, and dams which protect the land under cultivation from being flooded.

The overall length of levees on both sides of the river is 700 kilometers. In some places there are actually two lines of parallel levees connected by perpendicular levees called "traverses".

This system of protective dikes is very important since every year it is along this barrier that the struggle between man and river takes place. If the river is successful in breeching the dike then the water inundates a huge area, destroys crops and demolishes homes, villages, etc.

Along the lower courses of the river the terrain inclines both toward the Aral Sea and to the west to KARAKUL. Places can be pointed out along the river where when the river is in flood its water could be made to flow to the west practically without

help by man. It would be sufficient merely to destroy a short distance of protective dikes and levees along irrigation canals in order to make the river rush westward toward the [illegible] BASIN.

Topographic investigations, starting with the work of Glukhovski, have proved beyond doubt that if a sufficient quantity of water were released along the river's ancient course it would flow unobstructed to the Caspian.

Finally, attention should be called to the tradition of artificial regulation (opening and closing off) of the flow of water along the ancient bed.

We have already mentioned above that in olden times the KHIVINSKI KHANS controlled the upper end of the canals leading westward and maintained command over the Turkmen tribes settled along the lower reaches of the Amu-Darya. Water was let out of the Amu-Darya in part by allowing it to flow off along the ancient bed of the [illegible]-DARYA.

Right up to the present day there are still dikes to be found along the [illegible]-DARYA and they are far away from what are today's irrigated lands.

In 1[illegible]0, [illegible] I ROMANOV seeking to find land and water routes of commerce and communication decided to destroy the dam that was blocking one of the canals that flowed into the bed of the [illegible]-DARYA. According to information received from a nearby KHAN that particular dam had been built in 1[illegible]57 after the unsuccessful operations against the [illegible].

After the dam was destroyed the water flowed through the [illegible]-DARYA to the city [illegible].

The release of this water did not have any significant consequences since the KHAN who did it was only following ROMANOV's orders in order to demonstrate his obedience to the Russian government and as soon as Romanov left, the KHAN had the canal closed off again.

The release of this water did have a more important consequence, however, in that it demonstrated how very simply and easily a huge volume of water could artificially be made to change course and flow into the Caspian Sea.

A few words must be added to what has already been said on the external appearance of the UZBOY at the present time.

"It seems like only yesterday that the water stopped flowing in the UZBOY", are the words that can be found in the descriptions written by every traveller and explorer who has seen the UZBOY with his own eyes.

In actuality, the sands of KARA-KUM lie to the left of the UZBOY and the foothills

of the USTYURT mountains lie to the right.

Chains of sand dunes run right along the banks of the UZBOY. It would seem almost invitable that the very first wind would blow masses of sand into the UZBOY and cover it, but nevertheless the bed of the river is discernible right today for lengths of many tens and many hundreds of kilometers in some places.

The size of the bed varies. Here and there it resembles a huge man-made canal with a level bottom that is from 80 to 150 meters wide and with sloping banks that range in height from 5-6 meters to 30 meters. In other spots the banks of the river bed spread out sideways for 2-3 kilometers and form flood meadows through which the streams shallow/trace meanders. Since the ground water is so close to the surface in these meadows they are covered with green bushes and grasses.

Long stretches of the lower reaches of the UZBOY are full of ground water and the paths along the river bed run among trees in spots. It takes a careful scrutiny to discover that the water filling the bed is stationary and this lack of water movement is the only factor which makes the UZBOY, in this particular area, differ from an actual "live" river.

The variety of landscapes all along the UZBOY produces an impression of "freshness" for the river bed, and seems to emphasize the absence of silt and sand in the bed, while proclaiming the readiness of the bed once more to carry a stream of water.

It is difficult to believe that a river bed which cuts right across a sandy desert could still be in such a condition after all these centuries.

Thus it can be seen that historical information, topographic explorations, the entire natural environment of the lower course of the river, and the condition of the bed of the UZBOY, all confirm the conviction that relatively not long ago man by his own efforts produced a mighty flow of water and changed the face of the earth over an area of thousands of kilometers.

At the end of last century, however, scientists started to study the UZBOY, and among these geologists, geographers, and archeologists doubts as to the correctness of the historical information arose.

These scientists - naturalists - did not read the history of the UZBOY in manuscripts and stories, but instead read the history carved out over its entire length by the UZBOY itself. They found that the river had carried the ancient streams of water from the Amu-Darya to the Caspian Sea. In addition, these scientists also confirmed the historical information that claimed that not long ago (historically speaking) river

water had flowed along the bed of the KUNI-DA YA toward KARYKAMISH.

The final word in the history of the UZBOY has not as yet been spoken, but it is evident that in this argument between the geologists and historians truth lies with the former. Water could have flowed through the UZBOY only in the most distant antiquity - before the beginnings of the cultivation of the land in KHOREZM. Many geological and geomorphological facts indicate that this is true both for the UZBOY and the KARYKAMISH.

The certainty and conviction which fill many historian's writings may be explained by the the historians believing the flow of water from the Amu-Darya through the KUNI-DA YA to the KARYKAMISH Basin to be the current flowing through the UZBOY to the Caspian and mistakenly conceiving the huge KARYKAMISH Basin to be the Caspian Sea or one of its bays.

Actually, the flow of Amu-Darya water into the KARYKAMISH has started and stopped many times, both due to natural and artificial causes. Life and culture over an enormous area from the mouth of the Amu-Darya to the KARYKAMISH Basin have waxed and waned in consonance with the flow of water, and remains and relics of these civilizations exist today. Despite all this, the ancient bed of the UZBOY remains in excellent condition and is capable today of carrying Amu-Darya water into the arid regions of Southwestern TURKMEN so that in the future there can be an increase in the production capability of the Soviet Union.

THE PROBLEM OF SUPPLYING THE WESTERN TURKMEN AREA WITH AMU-DARYA WATER AND THE VARIOUS TECHNICAL PLANS TO SOLVE THE PROBLEM

The plan advanced by A. I. GLUKHOVSKI for artificially moving the waters of the Amu-Darya along the old bed of the UZBOY was the basis for the projected plan that was to answer the problem of irrigating the western Turkmen area by means of water from the Amu-Darya. In the next thirty to forty years after A. I. GLUKHOVSKI the problem of irrigating the western Turkmen area attracted the attention of many important Russian engineers. Only under the Soviet government, however, has the problem been treated in a systematic, purposeful manner.

Under the Soviet government special importance has been assigned to the investigative field work of the Institute for planning water conservation and hydrotechnical constructions in Central Asia (Centasiawaterproject), which was carried out in the summer of 1933 in the regions of the ancient (KUNI-DARYA) deltas of the Amu-Darya, the KARYKAMISH and the UZBOY. These explorations provided valuable, new, factual materials

illuminating especially the possibilities of running a canal thro and [illegible].

Below is presented a short summary of the various plans and projects suggested for solving the problem of providing Amu-Darya water for irrigation of the western Turkmen area. Each variant was suggested by a Russian working on the problem. Those shown here are the most well known of the various plans offered (in connection with them see Map, "Various Canal Routes").

1. KELIFSKO - KARAKUMSKI PLAN
2. [illegible]SKI PLAN
3. [illegible]UKHOVSKI PLAN
4. I. A. SHAROV PLAN
5. V. V. TSIMERLING
6. [illegible] WATER CUT (Central Asia Water Project)

As we discuss the characteristics of each of the suggested plans it will be very clear that the principal elements in the water routes suggested by most of the plans are the ancient beds of the Amu-Darya -- i.e. the Western UZBOY, the KELIFSKI UZBOY, the KUNI-DARYA, and the SARYKAMYSH BASIN.

One of the main elements in the detour part of the route is the ancient bed of the Western UZBOY. It is common to most of the plans we will discuss below. It is not, however, a main element in the KELIFSKO-KARAKUMSKI plan. In this plan the Western UZBOY is only partially utilized, since just its lower course play a part in the route.

KELIFSKI UZBOY is the name given to the chain of defiles and depressions, forming a stream bed, that lie between the sandy, dry spits running from the vicinity of BAMAK almost all the way to the RAVNINA railroad station on the ASHKHABAD railroad, a distance of about 300 kilometers. Water released from the KERKINSKI CANAL traveled about 110 kilometers along the KELIFSKI UZBOY.

The KUNI-DARYA is one of the ancient channels of the Amu-Darya. Its bed becomes discernible about 20-25 kilometers from the existing bed of the river and at its start it has the appearance of a gentle decline about 300 to 800-1000 meters wide and 1½-2 meters deep. Further along the bed turns to the northwest toward the city of KUNI-URGENCH. Its width decreases to 80-150 meters and its depth increases to 3-5 meters. From KUNI-URGENCH the bed turns westward and at the USTYURT CLIFFS it runs into the SARYKAMYSH BASIN. In this area the banks of the KUNI-DARYA rise abruptly in height and just before the bed reaches SARYKAMYSH the banks are more than sixty meters high. For seventy kilometers west of KUNI-URGENCH the banks of the river bed are covered by

ridges of semi-shifting sand. There are eight old dams along the bed.

The UZBOY and the [illegible] are described in detail in preceding chapters and therefore their characteristics are not discussed here.

Let us now proceed with a comparative estimate of the plans listed above.

The KELIFSKO-KARAKUMSKI PLAN

As already stated, this plan combines the recommendations that a canal be constructed in a man-made bed with the suggestions that the former bed of the Amu-Darya be utilized.

All of the plans which call for running a canal entirely in a man-made bed (YEREMEYEV and others) entail an enormous amount of earth moving work. In the sector from the Amu-Darya to the TEDZHEN river the amount of earth to be moved approaches 370 million cubic meters and the extension of the canal as far as the western Turkmen area would more than double this amount. In addition, if this route were used many concrete installations would have to be constructed in order to contain the erosion-active streams and for other reasons. For the reasons indicated plans of this nature have to be considered as impractical.

Another group of suggested plans that fall under the main category of the KELIFSKO-[illegible]SKI plan entail building a canal and utilization of an old channel of the Amu-Darya, the KELIFSKI UZBOY. Utilization of the KELIFSKI UZBOY was first suggested in 1925 by engineer F. P. [illegible] I as a result of exploration and investigations he made specially on this topic. According to his scheme the canal was to start near TYZYL-AYAKI and the bed of the KELIFSKI UZBOY was to be utilized farther along. His plan would provide irrigation for southeastern KARA-KUM and for the land along the lower reaches of the MURGAB and TEDZHEN rivers. The irrigated land was to comprise 1097 thousand hectares. This plan entailed movement of earth equalling 142 million cubic meters. The author did not say anything about extending the canal to the western Turkmen area, but in this event the canal would have to run entirely in a man-made bed for a distance of about 1,000 kilometers.

Engineer [illegible]KOV's idea for utilizing the bed of the KELIFSKI UZBOY was picked up by TOKAREVICH and used as the basis for the plan he advanced in 1932. This plan was to provide a small amount of water for the western Turkmen area. It was mainly to be

* Caption on picture Page 157 - HYDRAULIC operations on the Amu-Darya

used for supplying water to industry and providing water for the local truck-farming. The water supply was to be kept at the head of the already existing KERKINSKI CANAL, near the village of [illegible] close to the national boundary between the U.S.S.R. and [illegible]. The water would travel the first thirty kilometers through the already existing KERKINSKI CANAL and would then be released into the KELIFSKI UZBOY. A release of water similar to this is actually done at the present time. With relatively little work the sandy ridges can be removed and then there are no particular difficulties in getting the water to flow as far as the line of the railroad. From here on, according to TOLSTICHIN'S plan, the water was to flow through a natural depression called the South KARA-KUM Lowland. This runs for about 1140 kilometers and then joins the bed of the Western UZBOY. Through this latter the water could run without obstruction into the Turkmen areas near the Caspian Sea. The overall length of this route is about 1500 kilometers.

The author of this plan figured that if water came into the head of the canal at the rate of 99 cubic meters per second then the water would arrive two years later in the Caspian areas at the rate of 40 cubic meters per second. The amount of earth moving indicated by the author of the plan is extremely small, only 3 million cubic meters in all.

The job of making a current of water flow through a natural depression that has a general downward slant is possible in principle, but the implementation of this plan would undoubtedly run into many difficulties. The job of making the water flow through the upper part of the route (KELIFSKI UZBOY) and through the lower portion (Western UZBOY) is entirely possible of accomplishment. The fact that water has been flowing through the bed of the KELIFSKI UZBOY for the last twenty years testifies to this fact, and the bed of the Western UZBOY is in a much better condition than is the bed of the KELIFSKI UZBOY.

The central part of the route, from the railroad to the Western UZBOY, is more than 800 kilometers long and the author of the plan intended for it to run through the KARA-KUM lowlands. The first half of this part of the route is covered with high ridges of sand and the last half has many depressed areas that are free of sand and are covered by dry alkali flats (dry salt lakes). Thus we see that this part of the route is not endowed with as favorable conditions as the beds of the Western and KELIFSKI UZBOY offer. The first half of this section of the route is exceedingly difficult to traverse because the high sand ridges in the area would cause the

formation of huge lagoons and they in turn would cause a large loss of water due to evaporation and filtration. In the second half of the central portion of the route the formation of lagoons would be limited by cofferdams between the alkali flats. With respect to the loss of water due to evaporation and filtration this part of the route has relatively more favorable conditions, but nevertheless it also would cause a significant loss of water. In view of this, early preliminary figures indicate that water would have to be released into the head of the canal at a rate of not less than 200 cubic meters per second rather than 89 cubic meters per second as expected by the author of this plan.

The author's figure of 3 million cubic meters of earth to be moved is also too low by twenty or thirty times. The author of the plan evidently did not have the necessary topographical data to figure out properly the amount of earth moving work necessary. A more detailed examination of these materials makes one certain that the task of providing the western Turkmen area with a small stream of water by means of this plan would entail an enormous amount of earth moving work over a long distance and under extremely severe conditions. These conditions would change sharply if instead of sending a small flow of water along the intended route a large stream amounting to, say one-half of the Amu-Darya were sent along it. In this latter case the task of getting the water to the western Turkmen areas would be easier and most of the obstacles mentioned above could be surmounted. But, if such a quantity of water were taken out of the Amu-Darya it would be necessary to construct several dams along the river in order to ensure the necessary supply of water. These dams would be expensive and complicated technically. In addition, if this method were used we would have to put up with large and useless losses of Amu-Darya water.

The idea of [illegible] and the recommendation of [illegible]SEVICH were the bases for the exploratory and experimental operations of the water resources development project of the Ministry of Water Supply of the Turkmen S.S.R. In 1942 the Turkmen Water Development Project prepared a diagrammatic plan for a canal from the Amu-Darya to the river TEDZHEN and in 1946 projected the canal as far as the river MURGAB. The project includes irrigation of the land as far as the TEDZHEN with, if possible, a water supply of 252 cubic meters of water per second to be taken out of the Amu-Darya and no construction dams.

It should be mentioned that if the KARA-KUM CANAL were extended to the west a large

part of the land of the Caspian and KOPET-DAG plains areas would fall under its influence. Thus it can be seen that construction of the KELIFSKI-KARA-KUM canal in order to supply Amu-Darya water to the western Turkmen area and to use it to irrigate the Caspian and KOPET-DAG plains areas is entirely possible as far as topographic conditions are concerned. However, the actual job of construction as recommended by Morgunenkov and Tomasevich is not practical because of the enormous amount of earth-moving work entailed (in order to construct an artificial canal bed more than 1,000 kilometers long) and because it would bring about a severe change in the amount and flow of water in the Amu-Darya (in its central and lower reaches). This latter would be caused by the removal of huge quantities of water from the Amu-Darya near BASHAG or KYZYL-AYAK. These changes in the Amu-Darya mentioned above would necessitate the construction of additional dams, etc., on the river below the point at which the large amount of water was to be taken. These constructions would be necessary in order to ensure a supply of water to the irrigation systems already functioning near the mouth of the river and above it.

THE UNGUSKI PLAN

The Unguski Plan for getting water to the Caspian Sea owes its origination to the presence of depressions and salt flats near the southern foothills of the Northern (ZAUNGUSTI) Kara-Kums.

Map between Pages 160 and 161:

1. Various Plans for the Routes of the Canals
2. Caspian Sea
3. KARA-BOGAZ-GOL BAY
4. KARA-BOGAZ-GOL
5. KARA-KUM DESERT
6. KARAN-KULY
7. Peak B. BALKHAN
8. KOPET-DAG
9. KYL-KOR
10. VYSHKA
11. KYZYL-ATRAK
12. Depression of AKCHAKUL-AUDAK
13. SARYKAMISH BASIN
14. The plan of the Central Asian Water Project
15. Ancient bed of the Western UZBOY
16. KAZANDZHIK
17. KOPET-DAG Mountains
18. KYZYL-ARVAT
19. KELIFSKO-KARA-KUMSKI PLAN
20. KUNI-DARYA
21. GLUKHOVSKI PLAN
22. The bed of the DUDAN
23. Omitted
24. Northern (ZAUNGUSKI) KARA-KUMS
25. Omitted
26. Central (lowland) KARA-KUMS
27. ASHKABAD
28. ARAL SEA

29. CHIMBAI	43. ILDZHYK
30. NUCUS	44. CHARDZHOY
31. TAKHIA-TASH	45. TEDZHEN
32. DZHEMURAV	46. TEDZHEN River
33. TASHAUZ	47. MARI
34. URGENCH	48. BAYRAM-ALI
35. SHAROV'S Plan	49. MURGAB
36. DARVAZA	50. BUKHARA
37. UNGUZKI Plan	51. GYZHDUVAN
38. Chain of UNGUZ Alkali flats	52. KELIFSKI UZBOY
39. TYUYA-MUYUK Defile	53. KERKI
40. Amu-Darya	54. KYZYL-AYAK
41. DARGANATA	55. BASHIR
42. KARAKLY	56. ILKU

According to this plan the head of the canal was to be located near the ILDZHYKSKI Defile in the middle course of the river. The conditions for water supply are favorable since in this area natural exits for the water exist. The head section of the canal cuts across a plateau for the first 38 kilometers of its course, and there are depressions on this plateau that are from 5 to 12 meters in depth. For its next 583 kilometers the canal runs through the UNGUZ salt flats and sunken alkali beds. From this point on to its confluence with the Western UZBOY, 50 kilometers farther on, the canal must either fill a large depression and form a lake or it must have a man-made bed which can be dug so as to detour this depression. If the latter is done the loss of water due to evaporation and filtration would be lessened. The overall length of this route is about 1,250 kilometers. During 1930-1931 the first 200 kilometers of this route were explored with instruments by the Water Resources Directorate of the Turkmen S.S.R. In order to supply water to the western Turkmen S.S.R. at the rate of 30 cubic meters per second the volume of water taken from the Amu-Darya would have to be 200 cubic meters per second.

A very rough figure for the amount of earth-moving work necessary was calculated, and it came to 110 million cubic meters of earth. Included in this figure is the figure for the first 200 kilometers of the route; a section for which a more or less reliable longitudinal profile was available, and it alone was 95 million cubic meters. In order to ensure a water supply of more than 200 cubic meters per second it would be

necessary to build dams on the river and this would result (a it did in the other plans sugrested) in the necessity for construction of dams lower down the river also.

When all of these factors are taken into consideration it becomes clear that the amount of earth-moving work necessary and the intricate system of dams required show the UFUSKI to have no substantial advantages whatever over the "Southern" (KELIFSKO-KARA-KUMSKI) plans we discussed earlier.

The "Northern" plans for getting water from the Amu-Darya to the western Turkmen areas may be divided into two main groups:

1) The plans for getting the water by means of filling up the SARYKAMISH Basin with water and then having it flow farther through the Western UZBOY.

2) The plans for getting the water by means of running a detour canal around the SARYKAMISH Basin and then having the water flow farther through the Western UZBOY.

The authors of the plans that fall into the first group are (in chronological order): A. I. GLUKHOVSKI, Central Asian Water Resources Administration, I. A. SHAROV and V. V. TSINZERLING. The authors of the plans in group number two were A. I. LUKHOVSKI, The Central Asian Water Project Institute, and I. A. SHAROV.

A. I. GLUKHOVSKI'S Plan

The basis behind Glukhovski's first plan was the desire to make maximum utilization of natural conditions in the effort to create a water route from the Amu-Darya to the Caspian Sea. It is natural therefore that as his first plan for a route Glukhovski chose the one running: KUNI-DARYA -- SARYKAMISH BASIN -- UZBOY. Actually, in order to furnish water, this route requires a relatively small amount of work. The work necessary includes deepening of the KUNI-DARYA over its first 40 kilometers, removal of existing dams and a small amount of work to stop the Kuni-Darya from branching off near the Sarykamish Basin.

However, this plan for a navigable water route through the Kuni-Darya and across the Sarykamish Basin is endowed with a simplicity that is merely superficial and does not exist in fact. A detailed examination of the plan uncovers difficulties which even Glukhovski himself recognized correctly. The main difficulty is that the Sarykamish Basin would be turned into a lake more than 200 kilometers long and it would be completely exposed to the wind. This would be fairly dangerous for shallow draft vessels being towed by tug-boats. In addition, Glukhovski also figured that the lake thus formed would uselessly waste a large quantity of water as a result of evaporation (more than 350 cubic meters per second all year round). He also figured that a

continuous flow of 720 cubic meters per second would be necessary to keep the Basin filled and that at this rate it would take 15-17 years to fill it. Due to these reasons Glukhovski considered it more practical to construct a water route that would detour around the Sarykamish Basin and would make maximum use of the ancient bed of the Amu-Darya. He decided that the best track for such a water route would be along the Amu-Darya as far as the existing SHAKHMERAD Canal -- through the SHAKHMERAD Canal to the ancient bed of the DAUDAN and then along this bed into a specially constructed canal which would detour the Sarykamish Basin. The amount of water supply was expected to be 300 cubic meters per second. Since the bed of the Kuni-Darya was washed out for the first 38 kilometers from the Amu-Darya a man-made canal would have had to be built for this distance. From this point on for 140 kilometers the Kuni-Darya could be utilized without any earth-moving being required. On the Kuni-Darya, below the head of the SHAKHMERAD, Glukhovski intended to construct a variable dam in order to regulate the flow of water into this canal. He intended to rebuild the SHAKHMERAD Canal in order to make it passable for ships.

The greatest amount of work would be required in the construction of the 206 kilometer long canal that was to detour around the Sarykamish Basin. The terrain in this area is characterized by an extremely small amount of slope (1 centimeter per kilometer). Glukhovski intended to clear the canal of silt in this area by means of dredging.

Ten dams having navigation locks were to be constructed on the Western UZBOY. The overall length of this water route was 1,140 kilometers.

I. A. SHAROV'S PLAN

I. A. Sharov held that in addition to the already known ancient beds of the Amu-Darya in KHOREZM there was another one. This he called the "KHIVINSKI bed" and it ran along the southwestern edge of the KHOREZM OASIS, in the area where a string of lakes and depressions exists. Sharov based the existence of this bed on the fact that the amount of water capable of being carried by the ancient beds of the Amu-Darya in that area was not sufficient to account for carrying all the water of the river west to the Caspian Sea.

Sharov's plan for bringing water to the Western Turkmen area amounted to the following: water was to be taken out of the Amu-Darya above TASH-SAKI in two methods. In the first method water, without the use of dams, would be taken out at the head of the canal at the rate of 160 cubic meters per second (this would provide 100 cubic

meters per second of water at the end of the route). This water would follow a route which for 2½ kilometers from T[illegible]-BAKI would have to be a man-made bed across a ridge of natural minerals separating the Amu-Darya from the start of the "KHIVINSKI Bed". For the next 185 kilometers the current would flow through the natural "KHIVINSKI Bed" to the head of the old CH[illegible]-YAB Canal. The route then extends for 167 kilometers along the CH[illegible]-YAB canal to the southern end of the Sarykamish Basin (CHARYSHLINSKI BAY). From the point where the route flows into the CHARYSHLINSKI Bay the bed of the bed of the Western [illegible]Y is utilized all the way to the Caspian Sea. The length of this section of the route is 655 kilometers and the overall route length is 1,007 kilometers. It was intended that 10,000 hectares of land in the western Turkmen area would get primary irrigation. The second method was to build a dam near TA[illegible]-BAKI and thus increase the water supply to 800 cubic meters per second. This method would provide irrigation for 625,000 hectares.

The feeding of water to the irrigation systems of Southern KHOREZM and the KARA-KUL-AK area under this plan is controlled by the dam near TAJN-BAKI, while the dam at TAKHI-TASH controls the water for Northern KHOREZM. Twenty-three million cubic meters of earth would have to be removed for the first method, and the second method would require the removal of 14 million cubic meters of earth.

As stated earlier, the "KHIVINSKI Bed" plays a large part in [illegible]OV's plan, and it is the utilization of this "Bed" that brings about such a decrease in the amount of work required. Another help is the utilization of the old CH[illegible]-YAB Canal for 167 kilometers. The only thing wrong, however, is that the explorations of B. M. [illegible]SKI proved that no such "KHIVINSKI Bed" exists. The depression along the south-western border of the KHOREZM Oasis is only the line where two surfaces that are inclined toward one another meet. These are the surface of the KHOREZM Oasis and the surface of the Northern (ZAUNYUSKI) KARA-KUM[illegible]. This line where they meet shows none of the characteristics of an old river bed. The typical features of banks, braided channels, and silt in the bed are lacking. Individual aeolian sand ridges extend quite a way to the land of the KHOREZM Oasis and between these ridges there are lakes that run crosswise to what would be the direction of the "KHIVINSKI Bed". Releasing water into this "Bed" would be a catastrophe for the southern edges of the oasis since the entire strip of cultivated lands along the proposed flow would be inundated. Release of water through the "Bed" would also have harmful effects on land farther away from the "Bed", because the level of the ground water would rise and at the present time the

the ground water level is at the maximum permissible height. In order to avoid inundating the cultivated lands and to obviate any increase in ground water level it would be necessary to dig out and deepen the bed (i.e. make an artificial canal).

The CH[illegible]-Y B Canal is no longer actually in existence. There are only remnants of its dikes and these are dotted by the burrows of earth boring animals. The bed of the canal itself has been filled with soil to the point where it is now level with the surface of the earth.

As a result, the amount of work figured out as necessary by the author of the plan is actually deceiving. In actual practice the amount of work required would be extremely large and if it were done it would be harmful to the cultivated part of the oasis that already exists.

The Plan of V. V. TSINZERLING

In 1932 V. V. TSINZERLING suggested his plan for utilizing the water of the Amu-Darya for Western Turkmen areas. His plan was to allow the river to flow freely and fill up the Sarykamish Basin and then get it to flow on through the Western UZB Y.

According to this plan water was to be taken from the river at TAKHI-T[illegible]H, where a box dam was to be constructed. The author of the plan calculated that from the average flow of the river (over a period of years) which at this water gauge point amounted to 47 cubic kilometers per year, it would be possible to take 36 cubic kilometers per year or roughly 1,150 cubic meters per second. In flood periods of the river as much as 3,000 cubic meters per second would be taken. He recommended that the following track be used as the route: the existing ancient bed of the Amu-Darya -- Kuni-Darya. The upper part of the route, that is, the 75 kilometers just before the Kuni-Darya, was to be a wide bed between two dikes.

Following this route along the bed of the Kuni-Darya the water would have to fill up the Sarykamish Basin to a point 70 meters higher than the level of the Caspian Sea. From the Basin it would flow on through the Western UZB Y. The author calculated that it would take only five years to fill the Sarykamish Basin. It was also figured out that one million cubic meters of earth would have to be moved in order to construct the dikes along both sides for a distance of 75 kilometers of the upper end of the route.

V. V. TSINZERLING's recommendation was rather optimistic. The dikes planned by the author to carry the high flow of water amounting to 3,000 cubic meters per second were entirely unsatisfactory. As a result the amount of work he calculated must be multiplied several times. In actuality it would require no less than 11-13 years to

fill the Garrykamish Basin, and not 5 years as the author stated. The author simply did not concern himself with the useless loss of water, which would average no less than 350 cubic meters per second.

The Central Asia Water Project Plan

As a result of the fact that it was necessary to get water to the Western Turkmen area as soon as possible the basis of the Central Asia Water Project's plan was the construction of a route to carry a "small current" of water. The water was to be taken from the lower section of the Amu-Darya and the route was to detour around the Garrykamish Basin till it met the bed of the Western UZBOY.

The first recommendation that this route be used, as stated earlier, came from V. I. Glukhovski, but Glukhovski himself realized that this project would require a huge amount of earth moving work in connection with constructing the detour section of the route.

The plan advanced by the Central Asia Water Project was based on the explorations and instrument investigations that were made in 1933 by the Kara-Kum expedition.

Water was to be taken out of the river near DZHUMAR-TAU without the use of a dam. On the 320 kilometer section of the route that runs to the Western Uzboy partial use is made of the old bed of the Kuni-Darya. This was first planned so that 178 cubic meters of water per second would come into the head of the canal. Of this water 30 cubic meters per second would reach the water distributing point 946 kilometers away on the Western UZBOY.

It was calculated that construction of the detour canal would require 45 million cubic meters of earth to be moved, and of this amount 2[illegible] million cubic meters were rocky soils.

It was believed that if this primary construction work were accomplished it would ensure fresh water for the main industrial enterprises in the western Turkmen area and it would create a 10,000 hectare fruit and vegetable growing area which would serve the industries of the western Turkmen area and would in addition create the proper conditions for the development of cattle raising in the Kara-Kums.

Secondary measures were also to be accomplished. These included providing fresh water for all the industry of the Western Turkmen area, further development of cattle raising, mechanized irrigation of the areas to the west of the KYUREN-DAG mountains, development of irrigation in the Kuni-Darya region (lower course of the Amu-Darya), construction of a hydro-electric station on the UZBOY and utilization of the UZBOY as a

means of water transport from the Amu-Darya to the Caspian Sea.

A comparison of the plans we have discussed indicates that any proper solution of the problem should be based on the following primary principles: a plan must be chosen which would lead to final results in the fastest time and which would not involve the construction of complicated installations on the Amu-Darya itself, which would not entail a huge amount of earth moving work and a useless loss of huge quantities of river water due to evaporation and filtration. In addition, the plan chosen for providing water to the western Turkmen area must allow for the future development of agriculture and industry and must not complicate steps to be taken in the future for utilizing the land and water resources in other parts of the Amu-Darya Basin.

Keeping this point of view in mind during review of the plans we have discussed to create a water route to the western Turkmen area, we must first of all determine the possibilities of making use of the bed of the Kuni-Darya and of the huge Sarykamish Basin, the point at which the bed of the Western Uzboy starts. A more thorough examination of this problem forces one to regard these possibilities with extreme skepticism.

Without including the junction of the ARNAKH-AUDAN the Sarykamish Basin has a volume of approximately 320 cubic kilometers with a surface area of 9.6 thousand square kilometers. Say that we decided to fill the Basin by allowing almost the entire unrestrained current of the river to flow into it, but taking into consideration the development of irrigation in the river's basin during the period that the Sarykamish Basin is being filled. We can tentatively state that 70% of the river's flow would have to be taken at TAKHIA-TASH, and this would amount to 50 X.7 35 cubic kilometers per year, or roughly 1,1[illegible]0 cubic meters per second of the average annual flow. According to these figures, even if the loss of water due to evaporation is not considered, it would require about 320X35 or 9 years to fill the Basin. If the losses due to evaporation are included, and under these conditions they amount to at least a one meter layer of water per year or 9.6 cubic kilometers (310 cubic meters per second of the average annual flow) then in actuality it would take more than eleven years to fill the Basin even if the best possible conditions should prevail.

For a length of 100 kilometers the lower course of the ancient bed of the Kuni-Darya has a main waterway capacity of no more than 400-500 cubic meters per second. Thus, evidently at least one year and the expenditure of large sums would be required in order to prepare the bed properly. In addition, in order to carry the flow of about

3,000 cubic meters per second that would occur during flood stages it would be necessary to dike the Kuni-Darya and to construct new restraining walls along the bed for a distance of thirty kilometers (from the dam at TAKHIA-TASH to the Kuni-Darya).

In order to complete this work and to construct the dam at TAKHIA-TASH, a dam which would have to control a current of as much as 3,000 cubic meters of water per second into the Sarykamish Basin, would require at least four years, including one year of preliminary and preparatory work.

Thus, from the moment construction operations were started until the Sarykamish Basin was filled with water, and taking into consideration one year to prepare the bed of the Kuni-Darya would be a period of at least 16 years.

Further, after the Sarykamish Basin was filled with water the amount of water that would have to be taken out of the Amu-Darya would be as shown in the table below and would be comprised of the following elements (average annual current is considered as the basis). Irrigation in the Western Turkmen area and along the lower reaches of the Amu-Darya is taken into consideration. (Figures given are in cubic meters of water per second).

a) irrigation and water supply	600
b) supplementary expenditure of water for operating the hydro-electric plant on the UZBOY	50
c) making up for the losses due to evaporation in the Sarykamish Basin	300
Total	950

This means a total flow of 30 cubic kilometers per year.

These facts and figures show that the plan for getting Amu-Darya water to the Western Turkmen area by means of filling the Sarykamish Basin does not satisfy the primary requirements for a solution to the problem --- namely those of getting a sizeable current of water to western Turkmen areas in the minimal period of time and with a relatively small loss of water due to evaporation and filtration. As a result, this plan must be discarded and in order to accomplish what is required we must choose a plan which includes a canal to detour around the Sarykamish Basin.

As far as the bed of the Western UZBOY is concerned we must take into consideration its excellent state of preservation and its extensive length. These leave no doubt as to the fact that it could be utilized as a natural route over which the current could flow.

In the next chapter we will consider a possible plan for getting the water of the

Amu-Darya to KRASNOVODSK.

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[illegible] IN THE LEVEL AND VOLUME CAPACITY OF THE ARAL SEA

The removal of water from the Amu-Darya into the Main Turkmen Canal will reduce the amount of water flowing into the Aral Sea and will naturally affect its state and annual cycles. At the present time the Aral gets an average annual 49 cubic kilometers of water from the Amu-Darya and 15 cubic kilometers of water from the SYR-Darya. The surface area of the Aral Sea is about 70,000 square kilometers and it contains 1,100 cubic kilometers of water.

The flow of water from the rivers into the Aral Sea at the present time completely replaces the water lost by evaporation from the Aral's surface.

If roughly 17 cubic kilometers of water per year were taken out of the river at the water guage point near the dam at T[illegible]-TASH the flow of river water into the Aral would be reduced to 45-48 cubic kilometers per year. This would reduce the amount of water in the Aral and would cause a gradual decrease in its surface area until equilibrium was reached between the amount of water flowing in and the amount evaporating at the new sea level. Since the approximate yearly loss due to evaporation of the Aral is a one meter layer of water we can figure roughly that for each cubic kilometer of water that evaporates there must be a surface area of about 1,000 square kilometers. Thus, under the new conditions we can expect a decrease in the surface area by 15-20 thousand square kilometers (i.e. down to a total surface area of 50-55 thousand square kilometers. At this dimension there would be about 700 cubic kilometers of water in the Aral Sea and the water level would fall 6-7 meters below the present level. The salinity of the water would increase from 1 to 1½ percent.

This decrease we have discussed would take at least 200-300 years to occur. Only 3-4 meters of it could occur during the forthcoming decades and if the surface area of the Aral shrunk to 60,000 square kilometers it would hold 900 cubic kilometers of water and the salinity would increase by 1.2 to 1.3 percent.

This would have some effect on the fishing industry, but it would be rather limited since the entire catch of fish in the Aral Sea is only 3% of the catch of the whole U.S.S.R. At the same time, however, a lowering of the water level of the Aral would have a marked beneficial effect on conditions in the delta, since it would make it easier for drainage water to run off and would lower the level of the Amu-Darya's bayous and the ground water level in the vicinity of the delta.

Lowering the level of water in the Aral Sea would make it possible to dry up the marshy regions of the present delta and utilize them for cultivation of valuable bast and fibre plants, cotton and in some places rice.

Reduction in the amount of water flowing into the Aral Sea would in part be compensated for by a lowering of the amount of water lost during floods in the delta (this loss amounts to several cubic kilometers of water per year). This saving could be accomplished by systematizing the taking of water from the delta, by constructing a system of dikes and by repairing the beds of the bayous.

At the same time, there will also be a decrease in the flow of water into the Sea as a result of the increased expenditure of water for irrigation and for hydro-electric plants that are to be located higher up along the basins of the Amu-Darya and the Syr-Darya.

The End